A STUDY OF PION AND MUON BEAM TRANSPORT SYSTEMS FOR A 600 MEV SYNCHROCYCLOTRON

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This status report for grant NsG-636 covers the design of a flexible mounting facility for the pion-muon channel for the Space Radiation Effects Laboratory 600 MeV synchrocyclotron and for a study of the channel's performance. The report covers the period of August 6, 1966 - February 6, 1967.

I. MAGNET SPECIFICATIONS AND FABRICATION

The meson channel transports pion-muon beams internally generated from the synchrocyclotron to the experimental area, Phase III. The AEC fabrication plant in Paduca, Kentucky, is in the process of building the magnets. A visit was made to the AEC plant during the latter part of July, 1966 by the principal investigator, Mr. C. Stearns of SREL, and Mr. Draper Smith of Langley, NASA. Additionally, a trip was made by Mr. H. Hinterberger of the University of Chicago and Mr. Dr. Smith during the past winter to check on the fabrication proceedure. Mr. Hinterberger served as a consultant to the grant on this trip. At the present time, the construction is proceeding on schedule: coils for the main channel magnets are being wound, insulated and vacuum impregnated, and pole pieces are being fabricated. The Paduca plant has subcontracted the construction of the bending magnet to the National Coil Company. Tentative completion date is October of this year.

II. MECHANICAL DESIGN OF CHANNEL MOUNTING STRUCTURE

In order to have flexibility in the use of this channel, a mounting arrangement was engineered which permits a choice of positive or negative mesons and also a choice of their energy. The mechanical design study for this mounting of the quadrupole channel was undertaken in connection with Catalytic Construction Company and has been completed.

III. PROPERTIES OF AN INFINITE FOCUSSING CHANNEL WITH SUCCESSIVE QUADRUPOLE ROTATIONS NOT EQUAL TO 90°

The properties of an infinite magnetic quadrupole channel in which adjacent quadrupoles are rotated with respect to each other by an angle $\theta=180°/n$, $n=3,4,5,...$ were investigated. Operations are carried out in complete transverse plane phase space using 4 X 4 matrix transformations. The results, when compared with a conventional, $\theta=90°$, channel show that the latter to be, in general, optimal; the $\theta/90°$ channel giving higher flux only for small values of effective quadrupole length. (Nuclear Instruments and Methods, Vol. 44, No. 2, p. 301).

IV. NEGATIVE PION BEAM SEARCH

A π^- beam from an internal cyclotron target has been recently tested. A quadrupole doublet and a bending magnet were used to deliver the beam to the neutron meson experimental room. Range curves were taken with the results: flux = 500 K/sec with vibrating target, 150 K/sec with "harp" target, momentum 185 Mev/c.

In the above beam, a muon component appeared in the range curve at $\sim$1/6 intensity of the pion beam. In order to optimize the pion beam, a computer program was written which searches for maximum phase space overlap with given target area by varying beam system parameters. This program was utilized to initially adjust the positions and currents of the beam magnets.

The work was done with the combined efforts of Dr. R. Siegel, Dr. R. Welsh, Dr. M. Eckhause, Dr. J. Kane of the College of William and Mary. Drs. Stan Sobbotka and Klaus Ziock of the University of Virginia and C. Gotow of Virginia Polytechnic Institute made several independent runs on the π^- beam.

V. INSTRUMENTATION DEVELOPMENT FOR CHANNEL PERFORMANCE MEASUREMENT

Work has been done on the development of scintillation counter instrumentation for the detection of both positive and negative pion fluxes. For negative pions, both pulse height discrimination to select only pion captive stars, and selection of pulse height within a narrow energy range have been found to be successful. The feasibility of the latter scheme is due to the specific scintillator-light pipe system used in this lab, resulting in extremely low dispersion of pulse height due to mono-energetic pions incident upon the scintillator.